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ORIGINAL

APPROPRIATE TECHNOLOGY
Summary of Awards

Fiscal Year 1980

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ORIGINAL

NATIONAL SCIENCE FOUNDATION
Directorate for Engineering and
Applied Science
Division of Intergovernmental Science
and Public Technology
Washington, D. C. 20550

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INTRODUCTION

This report describes the awards made in Fiscal Year 1980 by the Appropriate Technology Research Program.

The Directorate For Engineering and Applied Science (EAS) supports research in Engineering and all fields of applied science. Within this Directorate the Experimental Research Program on Appropriate Technology aims to:

- Strengthen the science and engineering base needed to identify and develop promising appropriate technologies which have the potential for generalization beyond the initial application and which fall outside the responsibility or interest of mission agencies.
- Improve the understanding of appropriate technology as a concept in the development of science and technology and to understand better its role and impact on the United States' society and economy.

For the purpose of this program, appropriate technologies are defined as those which possess many of the following qualities: they are decentralized, require low capital investment, are amenable to management by their users, result in solutions that conserve natural resources, and are in harmony with the environment; they are small or intermediate in scale, take into account site-available natural and human resources, and are more labor than capital-intensive.

The program supports research on the following appropriate technology topics:

- Appropriate Technology and Urban Innovation.
- Small-Scale Industrial Technology.
- Recycling, Resource Recovery and Conservation.
- Appropriate Technology, Rural Revitalization and the Small Farm.
- Food and Nutrition.
- Appropriate Technology—Its Roles and Impacts on Society, the Economy and Technological Development.

For the past decade, NSF has supported research on a number of topics which meet the definition of appropriate technology. From 1977 to 1979, in response to Congressional Committee requests, NSF, by use of a survey, a workshop and seven regional forums, examined the needs and created a design for a formal appropriate technology program. In February 1979, NSF submitted the resulting appropriate technology program plan to Congress. The plan emphasized that support of research in this emerging field could be initiated by NSF.

In order to involve potential new, nontraditional performers in the program, a preliminary announcement was published in the December 1979 issue of the NSF *Bulletin* and mailed to a wide variety of diverse groups. The *Program Solicitation for Small Business Innovation Research* (NSF 79-59) solicited proposals for appropriate technology research in small-scale industrial technology; recycling, resource recovery, and conservation; and technology to improve the self-sufficiency of small-scale farming. In addition, individuals from nontraditional performing institutions were involved in the review process.

Following National Science Board approval on January 15, 1980, a general *Program Announcement* was widely distributed to the science and engineering research community, the small business community, community colleges and local appropriate technology groups and individuals. *Important Notice* No. 80, dated February 15, 1980, announced NSF plans to support "projects in research and education which will strengthen the base of scientific knowledge, trained personnel, and public understanding needed to identify and develop promising appropriate technologies."

References

1. "Appropriate Technology—A Program Plan of the National Science Foundation, Report by the National Science Foundation to the Committee on Science and Technology, U.S. House of Representatives" (February 1979).
2. "Appropriate Technology in the United States," NSF/RA 770066, Integrative Design Associates, Inc., NTIS Order No. PB 273099 (1977).
3. "Workshop on Appropriate Technology," NSF/RA 790002, Design Alternatives, Inc., NTIS Order No. PB 294030 (January 1978).
4. "Appropriate Technology in the Pacific Northwest, NSF/RA 790010, University of Oregon, NTIS Order No. PB 299792 (September 1978).
5. "Midwest Regional Appropriate Technology Forum," NSF/RA 790006, Indianapolis Center for Advanced Research, Order No. PB 300405 (October 1978).

6. "The Southwest Public Forum on Appropriate Technology," Vols. I-III, NSF/RA 790005, 7900005A, 790005B, University of Texas at San Antonio, NTIS Order No. PB 300530, 300531, and 300532 (December 1978).
7. "Tools for a Change—Proceedings of the Northeast Regional Appropriate Technology Forum," NSF/RA 790009, University of Massachusetts, NTIS Order No. PB 295518 (February 1979).
8. "Appropriate Technology—West Coast Forum on Appropriate Technology," NSF/RA 790003, University of Arizona, NTIS Order No. PB 298986 (February 1979).
9. "Southeastern Forum on Appropriate Technology," NSF/RA 790007. Georgia Institute of Technology, NTIS Order No. PB 298796 (April 1979).

DEFINITIONS

The brief summaries which follow are provided for projects funded in Fiscal Year 1980. An alphabetical listing of awards by Performing Organization is included in Appendix A.

- "Award" refers to financial support given in the form of a grant, contract, or other arrangement, depending upon the nature of the research work to be completed and the terms of performance.
- "Effective Date" refers to the date specified in the award on which NSF funding becomes active (i.e., the date allowable costs may be charged against the award).
- "Principal Investigator/Project Director" refers to the individual designated by the awardee (and approved by NSF) who is responsible for the scientific or technical direction of the project.
- "Institution" refers to any college, university, public or private laboratory, industry, or other organization, whether operating for profit or on a nonprofit basis, as well as State and local governments and Federal organizations.

Where awards have received support from other organizations within or outside of NSF, only Appropriate Technology Program support has been indicated except where otherwise shown.

SUMMARY OF AWARDS

Cost Reduction In Irrigation Well Pump Application; Joseph T. Hamrick, Aerospace Research Corporation, 5454 JAE Valley Road, S. E., Roanoke, VA 24014; $24,952 for 6 months beginning September, 1, 1980.

The objective of this research is to determine whether rotational motion of water that can be induced by its passage across vanes ahead of the impeller of a pump can extend the range of flow over which the pump can operate with maximum efficiency. All factors that affect the performance of a standard water pump with a nominal capacity of 600 gallons per minute are being evaluated to determine the optimum placement and angle of the vanes for extending the range of maximum efficiency.

This project for conduct of feasibility research results from a proposal submitted to NSF under the Program Solicitation for Small Business Innovation Research, NSF 79-59.

Biological Stabilization of Organic Substances in Municipal Solid Waste by Composting; Meade Cadot, Antioch College New England Graduate School, 103 Roxbury Street, Keene, N.H. 03431; $36,974 for 24 months beginning October 1, 1980.

This project addresses the problem of municipal solid waste management in smaller communities in northern latitudes by evaluating the technical and economic viability of several methods of composting the wastes. Methods being studied include several variations of the induced aeration method and one based upon use of earthworms. The research is being conducted at the Wilton, New Hampshire Recycling Center and is a collaborative effort by the Antioch College New England Graduate School, Recycling and Conservation, Inc., the Wilton town recycling staff, and the Department of Plant Science of the University of New Hampshire in Durham.

Testing and Evaluation of Equipment Used in Recycling Centers; George M. Savage, Cal Recovery Systems, Inc., 160 Broadway, Suite 200, Richmond, CA 94804; $20,772 for 6 months beginning September 1, 1980.

The objective of this project is to assess the feasibility of conducting resource recovery from municipal solid waste at small recycling centers. The important components of resource recovery systems are being identified and equipment currently available for each step is being evaluated to determine performance characteristics. The efficiency of separation, operational and maintenance characteristics, safety, and environmental considerations are being evaluated for each of the system components. The feasibility of separating metal containers, fabricated from combinations of steel and aluminum, is being investigated for application at small recycling centers.

This project for conduct of feasibility research results from a proposal submitted to NSF under the Program Solicitation for Small Business Innovation Research, NSF 79-59.

Evaluation of Curbside Municipal Solid Waste Sorting Systems; James P. Bosscher, Calvin College, Grand Rapids, MI 49506; $15,855 for 6 months beginning September 1, 1980.

Three alternative systems for curbside sorting of municipal solid wastes are being mathematically simulated for evaluation of their feasibility and comparative efficiencies with regard to use of labor, energy and time as well as their relative cost.

The first system consists of a packer unit and collection bins for cans, glass containers, and newspaper. The second system combines processing machinery, storage bins, and packer unit into one vehicle. The third system is a detachable processing unit which contains a glass smasher, plastic shredder, can crusher, and storage bins pulled by a packer unit. The mathematical simulation of these systems considers variability in degree of individual household participation. Results are expected to determine the optimal capacities of the three systems with regard to household waste percentages, compare their energy and labor efficiencies including all costs from collection to final storage at the recycling center, and provide a basic program that will be useful to communities in planning recycling strategies.

Management of Decentralized, On-Site Systems for Treatment of Domestic Wastes; Robert C. Ward, Colorado State University, Fort Collins, CO 80523; $75,172 for 24 months beginning September 1, 1980.

The objective of this research is to define the nature and scope of centralized controls that are necessary for operation and maintenance of decentralized, on-site systems for management of wastes derived from human sources in order to insure adequate protection of public health and environmental quality. The scientific and technical bases for design of the components of a prototype management system that are being identified in this project include parameters for determining the quality of system performance, the necessary frequency of monitoring, the types of data that are needed to assess adequacy of performance, and the need for supporting systems such as procedures to manage the residues that result from operation of on-site waste treatment systems. These technical and scientifically-based conditions that must be met for successful installation and reliable operation of on-site systems are being characterized in the context of the type of management organization and program that will assure acceptable standards of performance, protection of public health, and compatability with regional environmental quality.

Correlation Between Early Linear Measurements and Future Performance and Carcass Characteristics in Cattle; Sherman M. Seltzer, Control Dynamics Company, 701 Corlett Drive, Suite 2, Huntsville, Al 35802; $24,813 for 6 months beginning September 1, 1980.

The objective of this project is to assess the feasibility of using easily obtained, linear measurements of calf-frame characteristics to predict animal performance and quality. Measurements are being made of potentially useful characteristics minimally at birth and at seven and fourteen months of age. Approximately 1200 animals are being surveyed during the initial phase of this research to identify those measurements most highly correlated with animal performance and quality consistent with ease of measurement.

This project for conduct of feasibility research results from a proposal submitted to NSF under the Program Solicitation for Small Business Innovation Research, NSF 79-59.

Small Scale Reclamation/Disposal of Toxic Porcelain Enameling Wastewater Sludges; Karl G. Voelkel, Donohue & Associates, Inc., P.O. Box 1067, Sheboygan, WI 53081; $25,000 for 6 months beginning September 1, 1980.

The aluminum porcelain enameling industry generates, as a byproduct, small quantities of inorganic wastewater sludges which contain significant amounts of heavy metals including lead, chromium, cadmium, and selenium. The objective of this project is to determine the feasibility of small scale, on-site methods for use in managing the porcelain enameling process sludges. The methods being studied include potential use of alternate raw materials, recycling of the sludges to minimize the amount produced, removal and separate disposal of objectionable heavy metals, encapsulation and fixation of the heavy metals, and conditioning and placing the sludges in on-site segregated landfills.

This project for conduct of feasibility research results from a proposal submitted to NSF under the Program Solicitation for Small Business Innovation Research, NSF 79-59.

An Inexpensive Biologic Method of Upgrading Lagoon Effluent; Gordon R. Pyper, Dufresne-Henry, Inc., Precision Park, North Springfield, VT 05150; $25,000 for 6 months beginning September 1, 1980.

The objective of this project is to determine the feasibility of using fresh water mussels (*Lampsilis radiata*) to improve the efficiency of oxidation ponds used for treatment of domestic wastewater. The study includes determination of maximum organic loading, heavy metal tolerance, and the effects of temperature, dissolved oxygen concentration, and pH on the ability of mussels to perform a treatment function in the ponds used. Mussels are being obtained from their natural habitat in Lake Champlain for laboratory and field evaluation of their potential for reducing costs and for improvement of the effluent quality from oxidation ponds used to provide secondary treatment for wastewater from small communities.

This project for conduct of feasibility research results from a proposal submitted to NSF under the Program Solicitation for Small Business Innovation Research, NSF 79-59.

Small Purification Systems; John McCallum, Electro-Chlor Corporation, 5926 Beechview Drive, Worthington, Ohio 43085; $25,000 for 6 months beginning September 1, 1980.

The objective of this project is to determine the feasibility of producing solutions of chlorine from table salt and from spent water softener brines for use in disinfection of domestic wastewater. Small electrolytic cells are being evaluated to determine the design requirements for their use in small water and wastewater treatment systems. The production of chlorine from water containing relatively low concentrations of chloride ions is being investigated for potential application in disinfection of drinking water.

This project for conduct of feasibility research results from a proposal submitted to NSF under the Program Solicitation for Small Business Innovation Research, NSF 79-59.

Anaerobic Upflow Treatment of Household Wastewater; Michael J. Coblentz, Farallones Institute, 1516 Fifth Street, Berkeley, CA 94710; $6,850 for 6 months beginning September 1, 1980.

Research is being conducted to determine the reaction rate constants, temperature coefficients and nutrient requirements for anaerobic treatment of household wastewater using a process where the wastewater flows over surfaces on which biologically active films have developed. Initial studies, based on use of a synthetic wastewater containing typical household detergent, oils, and grease are being used to guide evaluation of the concept on actual household wastewater. The hydraulic characteristics of the upflow system are being studied by use of a dye-tracer. The performance of the process is being characterized by the degree to which it reduces the chemical oxygen demand, oil and grease content, and detergent as measured by the Methylene Blue Active Substance (MBAS) procedure.

Appropriate Environmental Systems For Waste; Howard T. Odum, University of Florida, Gainesville, Florida 32611; $27,299 for 12 months beginning October 1, 1980.

The objective of this project is to determine the feasibility of evaluating alternative systems for management of wastes by taking into consideration resources consumed as well as those freed for other uses. The project is based upon results of prior research supported by NSF Grant No. PFR 77-06013 in which cypress wetland ecosystems were used to manage wastewater derived from domestic sources. The project assesses the potential applicability of concepts derived from the cypress wetland ecosystems study to the management of wastes derived from production of paper, leachate from sanitary land fills for domestic solid wastes, and for wastes from mining of phosphates. Potential sites for future studies are being identified. The results of this planning phase will provide the basis for convening a workshop in September 1981. The workshop will address the scientific basis for selection of experimental sites, the experimental procedures to be used in evaluating performance, and assess further research needs.

Biodegradable Solid Waste Conversion Into Earthworm Castings; Mary Appelhof, Flowerfield Enterprises, 121 E. Van Hoesen, Kalamazoo, MI 49002; $25,000 for 6 months beginning September 1, 1980.

Stabilization of the organic matter in household kitchen wastes by use of earthworms has been determined to be technically feasible for small, single and multiple family dwelling units. The practicability of using this concept to provide for small-scale, decentralized conversion of household kitchen wastes into earthworm castings for use as a soil amendment will depend upon its acceptability by potential users. The objective of this project is to determine the role that attitudes of residents, managers, owners, and developers of multi-family residential units have toward use of earthworms to process household kitchen wastes in modular units designed for multiple family dwellings. This information is being used to determine whether it is feasible to design an acceptable system specifically for multi-unit dwellings and to define the living or housing situation optimal for acceptability of this concept of conserving the resource values contained in household kitchen wastes.

This project for conduct of feasibility research results from a proposal submitted to NSF under the Program Solicitation for Small Business Innovation Research, NSF 79-59.

Managing a Small Scale Solid Waste Resource Recovery Facility; Robert C. Jones, Floyd Browne Associates, Ltd., 181 South Main Street, Marion, OH 43302; $24,793 for 6 months beginning September 1, 1980.

The objective of this project is to determine the feasibility of modifying small landfill operations for management of mixed household refuse to include resource recovery. Resource recovery is being evaluated when practiced at the working-face of an operational landfill. The study includes assessment of the quality of extracted materials, site-burial for temporary storage, and seasonal variations in recoverable components of the waste. Ferrous metal separation is being accomplished by an electromagnet and non-ferrous metals are being removed by hand from a conveyer belt. The apparatus being used is portable for movement to alternative locations during the placement operations.

This project for conduct of feasibility research results from a proposal submitted to NSF under the Program Solicitation for Small Business Innovation Research, NSF 79-59.

Utilization of Wetlands for Wastewater Management; Ronald G. Capalaces, Forum, Ltd., 6512 Jay Miller Drive, Falls Church, Virginia 22041; $14,500 for 1 month beginning April 1, 1980.

This is a supplemental award for production of a 16 mm film in sound and color that documents results of research currently underway on utilization of wetlands for management of community wastewater. This film will provide information and guidance to communities considering the potential utilization of wetlands as an alternative to conventional methods for advanced treatment of their wastewater. The film is based upon research currently in progress that is being supported by the following NSF grants:

University of Michigan, Robert H. Kadlec (PFR 77-23868

Williams & Works, Inc., Jeffrey C. Sutherland (PFR 77-20373)

University of Florida, Howard T. Odum (PFR 77-06613)

Boyle Engineering Corporation, Walter Fritz (PFR 78-19199)

State of Florida, Epidemiology Research Center, Flora Mae Wellings (PFR 77-26849)

The award to which this is a supplement was made in accord with procedures contained in the National Science Foundation's Request for Proposals, FRP 79-119, dated March 9, 1979. The award number is NSF Contract No. PFR 79-23303.

Elimination of Septic Tank Sludge Transport Via Truck; George D. Ward, George D. Ward & Associates, 821 N.W. Flanders, Portland, OR 97209; $24,728 for 6 months beginning September 1, 1980.

The objective of this project is to determine the feasibility of managing liquid residues from septic tanks by disinfection with lime within the tank prior to removal of the residues for incorporation into topsoil by direct injection. The system being studied is proposed to be transportable to each site as an alternative to a centralized system.

This project for conduct of feasibility research results from a proposal submitted to NSF under the

Program Solicitation for Small Business Innovation Research, NSF 79-59.

Susceptibility of Mt. St. Helens Volcanic Ash to Stabilization by Use of Organic Sludges, George D. Ward; George D. Ward & Associates, 821 N.W. Flanders, Portland, OR 97209; $11,687 for 3 months beginning June 10, 1980.

The main objective of this research is to determine the properties of Mt. St. Helens volcanic ash which are of significance with regard to erosion by water and wind and to determine conditions under which stabilization of the ash could be accomplished by use of organic wastes from municipal, commercial, and industrial sources. The characteristics of the ash are being determined as a function of the heights of ejection, wind velocity, and total distance traveled. Bench scale studies of seed germination and plant growth in mixtures of volcanic ash, municipal sludges, and paper mill sludges are being conducted. Municipal sludges are being evaluated for their ability to provide nutrients for plant growth. The paper mill sludges, which contain wood fibers, are likely to enhance the ability of the mixtures to withstand erosion during germination of seeds and establishment of ground cover.

Development of Mineral Wool from Industrial Wastes, Mir Akbar Ali; Glass & Ceramics International, Inc., 26430 Via Marquette Lomita, California 90717; $24,961 for 6 months beginning September 1, 1980.

The objective of this project is to assess the feasibility of converting mixtures of cement kiln dust and the ash residue from combustion of coal into a mineral product resembling rock wool and potentially capable of being used for analogous applications. The coal ash being used in this research is from a Southern California Edison power generating plant and the cement kiln dust is from the California Portland Cement, Inc. Mohave Plant. The coal ash and cement dust residues are being ground, screened, chemically characterized, mixed in varying proportions, melted and then cooled by placement in aerated water. The products are being analyzed and compared with commercial mineral wool products.

This project for conduct of feasibility research results from a proposal submitted to NSF under the Program Solicitation for Small Business Innovation Research, NSF 79-59.

Appropriate Technology, Innovation, and Nonfarm Rural Development, Norman A. Bergan; Industrial Technology Research and Development Foundation, Inc., P. O. Box 1335, Durant, Oklahoma 74701; $145,088 for 12 months beginning September 1, 1980.

Research is being conducted to determine the indigenous appropriate technology base in southeastern Oklahoma, assess the underlying socioeconomic value systems with respect to work, economic development, and science and technology, and identify major indigenous resources having the potential for the application of science to appropriate technology needs. The study is determining the role of science and engineering in implementing appropriate technology within the region, examining how a nonprofit, technology-oriented development organization can draw on science and technology in formulating a plan of action to foster the appropriate technology of this region and general economic growth.

Oklahoma State University is assisting in the conduct of this research under a subcontract with the Industrial Technology Research and Development Foundation, Inc., a nonprofit corporation.

Research on Permanent Cropping System for Small-Scale Farms, Thomas B. Fricke; International Science and Technology Institute, Inc., 1129 20th Street, N.W. Suite 511, Washington, D.C. 20036; $25,000 for 6 months beginning September 1, 1980.

The objective of this project is to study the merits and problems associated with an alternative to conventional agricultural practice and to determine its feasibility. The alternative system is based upon concepts of minimum tillage, intensive cropping, and dependence on organic substances as soil additives to improve and sustain its quality. The relative and combined merits of these concepts are being considered to devise the optimum combination of processes, equipment, and management strategies for potential adoption as a permanent cropping system for small farms.

This project for conduct of feasibility research results from a proposal submitted to NSF under the Program Solicitation for Small Business Innovation Research, NSF 79-59.

A Research Agenda on the Roles and Impacts of Appropriate Technology on Society, The Economy and Technology Development; Joseph F. Coates; JF Coates Inc., 3738 Kanawha Street, N.W., Washington, D.C. 20015; $7,400 for 2 months beginning November 12, 1979.

The purpose of this project is to review the NSF Appropriate Technology Program Plan along with other relevant documents, and to prepare a report which contains a plan to support and conduct research to implement the program element, "Appropriate Technology—Its Roles and Impact on Society, the Economy and Technological Development". The report addresses the content and products of research; the process for obtaining and using the research results; and the resources required to implement the plan, in terms of time, funds and personnel. Subjects treated in the report include: Social and Economic Implications of Appropriate Technology; Role of Appropriate Technology in Technological Innovation; and Manpower and Training Issues in Appropriate Technology.

Appropriate Technology of Alternative Agricultural Practices on Drylands, Mary Beth Kirkham; Agricultural Experiment Station, Kansas State Univer-

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sity, Manhattan, KS 66506; $63,766 for 24 months beginning August 15, 1980.

The objective of this project is to determine whether agricultural practices emphasizing the use of organic sources of plant nutrients result in significant differences in the productivity of agricultural land and the quality of wheat grown on it when compared with conventional farming using inorganic fertilizers. Winter wheat is being grown on a previously barren soil that has undergone desertification and on good agricultural soil on which crops have previously grown. The organic material being used in this study is sludge derived from treatment of wastewater at Manhattan, Kansas. Field test plots are located near the treatment plant and at a dryland site in western Kansas. Plant samples are being analyzed for their content of major nutrients and trace elements. Water loss from plant leaves and the moisture content of soil in the test plots are being determined at regular intervals. Plant height and leaf area during growth are being measured. Land productivity and grain quality parameters are being determined at harvest. The quality parameter selected for the grain is its protein content. Soil samples taken at the conclusion of the experiment will be analyzed and their quality compared with those taken at the beginning of this study.

Beneficial Use of Sludges in Production of Building Components, James E. Alleman; University of Maryland, College Park, Maryland 20742; $41,140 for 12 months beginning October 1, 1980.

The objective of this project is to define the limits of feasibility for use of sludges derived from treatment of industrial and municipal wastewater in production of ceramic building components such as brick. The relative proportions of sludge and clay are being varied to determine the relationship of these ratios to the quality of the product. The structurally important, physical assessment of product quality is being conducted according to procedures recommended by the American Society for Testing Materials. The impact of variations in sludge characteristics such as its moisture content and chemical composition on the quality of the product is being characterized. The upper boundary of permissible sludge content in the clay mix prior to firing as determined by acceptability of the product will establish the feasibility of this concept as a means for coping with sludges produced in treatment of municipal and industrial wastes. This research is being conducted in cooperation with Maryland Clay Products, Inc. of Laurel, Md.

Appropriate Technology From a Social Science Perspective, Denton E. Morrison; Michigan State University, East Lansing, Michigan 48824; $73,520 for 12 months beginning September 1, 1980.

The purpose of this project is to develop the conceptual, propositional, and methodological framework needed for subsequent social science empirical examination of appropriate technology. The project aims to answer the following questions: (1) What is appropriate technology as a set of concepts and propositions? (2) What social science knowledge bears on these concepts and propositions? (3) What is the status of appropriate technology as social scientific knowledge, and what needs to be done to improve social science knowledge about appropriate technology? The project work plan includes systematic identification, acquisition, and analysis of the relevant literature, plus the use of consultants for criticism of the draft-report.

Solids Movement in Wetlands, Robert H. Kadlec; University of Michigan, Ann Arbor, MI 48109; $37,528 for 12 months beginning September 1, 1980.

The objectives of this project are to characterize and assess the significance of the movement of solids through a wetland that is being used for management of the water and nutrient content of the effluent from a domestic wastewater treatment facility at Houghton Lake, Michigan. This research is complementary to and based upon results from research supported under NSF Grant No. ENV 77-23868.

In this project, the algae and invertebrate components of the wetland ecosystem are being studied to determine their role in movement of both organic and inorganic solids. Analytical techniques include use of electron microscopy and neutron activation. Studies include vertical and horizontal movement of solids under sedge, leatherleaf, and cattail types of vegetative cover during a single season of operation.

Disequilibrium of Hydrogen Sulfide in Groundwater by Aeration, Joseph D. Ritchey; National Water Well Association, 500 West Wilson Bridge Road, Worthington, OH 43085; $22,686 for 12 months beginning September 1, 1980.

The objective of this research is to determine the feasibility of separating hydrogen sulfide from solution in groundwater by aeration of the water within the aquifer. The research is being conducted at five locations within the continental United States selected for their variability with respect to the concentration of hydrogen sulfide, the quantity of water used, and system design. At each location, compressed air is being diffused into the groundwater near the pump intake and within the well casing. The hardness, pH, and oxidation-reduction potential of water withdrawn from the experimenal wells are being determined as are the concentrations of hydrogen sulfide, sulfates, and dissolved iron. The process of aeration is expected to result in deposition of calcium carbonate on the immersed surfaces. Data are being used to characterize the nature and amount of the calcium carbonate deposits which are likely to adversely affect the performance of the wells within which aeration is being conducted.

The Applicability of Traditional Navajo Decision-Making to Modern Ecological Conditions, G. Mark Schoepfle; Navajo Community College, P.O. Box

580, Shiprock, N.M. 87420; $56,288 for 12 months beginning September 1, 1980.

The purpose of this project is to conduct research to describe the perceptions associated with traditional Navajo agriculture and pastoralism, and to create a decision model for understanding the factors involved in their traditional practice concerning land use.

The use of land resources is one of the most important problems in the economic life of this tribe, the largest single Native American group in the United States. Linked to their use of land are issues of environmental quality, economic growth, and social wellbeing. Specific problem areas include: tribal water rights; energy resource development; environmental degradation; stagnation of small scale agriculture and financial difficulties associated with larger scale coporate tribal agriculture; range management; a declining subsistence base; and family and cultural disintegration.

Since policies affecting land use have tended to be imposed top down and neglect the perceptions and practices associated with traditional agriculture, pastoralism, and use of the environment, the project will adress this issue by describing such perceptions and creating a factual decision model based on them.

The research results will be useful for Navajos in making decisions about appropriate uses of their environment, and may have potential for addressing problems in comparable areas of the West.

Feasibility of Small Scale Aquaculture Based on Recycling of Renewable Resources, Ronald D. Zwieg; The New Alchemy Institute, 237 Hatchville Road, East Falmouth, Massachusetts 02543; $120,277 for 15 months beginning October 1, 1980.

The objective of this project is to evaluate new concepts in the conduct of small-scale aquaculture resulting from previous research conducted under NSF Grant No. OPA 77-16790. Ecosystem and economic models of aquaculture systems that were developed during prior research are being used to determine the optimum design and operating conditions for conducting aquaculture in small, outdoor ponds. This preliminary validation of the optimum design is being conducted to provide the basis for any necessary modification of the ecosystem and economic models.

A number of concepts are being evaluated in order to determine their effectiveness in improving the productivity of the aquaculture system through recovery of nutrients and removal of potentially toxic metabolites. These concepts include: assimilation by algae; hydroponic plant culture; bacterial nitrification and denitrification; and the exchange of water with adjacent land used for conducting conventional agriculture. Results of this research are being used to assist in structuring a workshop planned for September 1981 to assess the scientific basis for design and operation of pond aquaculture systems and to determine further research needs for their design and successful operation.

International Workshop on Earthen Building Materials and Methods in Seismic Areas, Gerald W. May; University of New Mexico, Bureau of Engineering Research, Farris Engineering Center, Room 124, Albuquerque, New Mexico 87131; $30,000 for 17 months beginning April 15, 1980.

This proposal is for the planning, management, and documentation of an international research workshop on the improvement of seismic resistance of earthen low-rise buildings in earthquake-prone areas. The proposed workshop will bring together a select group of domestic and foreign researchers in order to achieve the following objectives: (1) to develop a clear statement of the problems associated with earthen low-rise buildings in seismic areas; (2) to define the existing state-of-the-art with regard to earthen building materials, design and construction methods in seismic regions; (3) to identify and categorize existing national and international research findings in related areas and seek to establish their applicability to the seismic design and construction of earthen buildings; (4) to identify appropriate channels for technology transfer across international boundaries, and to explore social and economic barriers to such transfer; (5) to identify opportunities for cooperative international research; and to identify and describe the gaps in the present body of knowledge, and to define research needs.

The workshop is to be held at the University of New Mexico, Albuquerque, New Mexico. The workshop will bring together the relevant domestic earthquake engineering research with researchers from other earthquake prone countries with significant adobe construction. The workshop is planned for May 1981.

The workshop will result in two reports which will serve as a guide to current research and will define future research needs.

Workshop on Decentralized Systems for Management of Water, Solid and Liquid Wastes, Robert L. Irvine; University of Notre Dame, Notre Dame, Indiana 46556; $39,718 for 8 months beginning April 1, 1980.

Recent advances in control systems have led to the application of variable-volume, periodically-operated systems for management of solid and liquid wastes and treatment of water. In contrast to conventional, continuous-flow systems, sequencing of a batch reactor offers the potential of adjusting the degree of treatment to variations in flow and composition of the material being treated. The concept has been suggested as being particularly applicable for serving needs for decentralized, low-capital investment, water and wastewater treatment systems as alternatives to conventional approaches which are not adaptable to being managed by their users. The advantages of the controlled periodic method of operating treatment plants include benefits resulting from equalization of strength, quiescent sedimentation, modular construction, and ability to retain total control over final discharge of the effluent until its quality is found to meet discharge criteria.

The objective of this workshop held in June of 1980 is to explore the range of potential applicability of treatment systems based on sequencing of batch reactors and to identify research needs with emphasis on application of this concept to decentralized, low capital investment systems for solid waste, liquid waste and water management.

Alternative Technologies For Small Water System Management, Arun K. Deb; Roy F. Weston, Inc., Weston Way, West Chester, Pennsylvania 19380; $99,987 for 12 months beginning October 1, 1980.

The objective of this research is to devise methodology for analysis of alternatives that small communities have to provide their residents with water of potable quality. The alternatives being considered include the development of new sources, provision of dual piping systems, use of alternatives to pipeline distribution for potable water, and point-of-use conditioning of subpotable water to meet potable standards of quality. This research is based upon results of prior work supported under NSF Grant No. PFR 76-18499 which led to the formulation and subsequent validation of a mathematical model for use in analyzing moderate to large water supply systems. In this project, the prior approach is being modified to accomodate concepts, processes, and unit operations that are uniquely applicable to water supply systems serving between 100 to 10,000 persons.

Earthworm—Microbial Interactions During Stabilization of Organic Wastes for Recovery of their Resource Values, Roy C. Hartenstein; State University of New York Syracuse, N.Y. 13210; $73,765 for 12 months beginning June 1, 1980.

The objective of this research is to determine the feasibility of converting mixtures of paper wastes and municipal sludges, and mixtures of paper wastes and inorganic microbial nutrients into earthworm castings which can be used as soil amendments. Earthworm-microbial interactions are being studied to determine the optimum ratio of carbon to nitrogen for achievement of maximum rates of stabilization in mixtures of activated sludges which are high in nitrogen and in paper-mill sludges which are relatively deficient in nitrogen. The addition of selected inorganic nutrients is being investigated for their potential role in accelerating the rate of stabilization and in enhancing the value of the earthworm castings that are produced. Mixtures of cellulose, inorganic nutrients, and soils are being inoculated with selected species of bacteria and earthworms to determine conditions under which the maximum rate of decomposition and stabilization can be achieved. Bacterial species being evaluated for potential fixation of nitrogen include *Azotobacter vinelandii* and *Clostridium pasteurianum*. This research is concentrating on the earthworm species *Eisenia foetida* but includes several others such as *Eudrillus eugeniae* and *Allolobophora chlorotica*. This research is based upon prior studies that were conducted with support from the National Science Foundation under Grant No. PFR 78-09331.

Workshop on the Role of Earthworms in Stabilization of Organic Residues, Robert W. Kaufman; Western Michigan University, Kalamazoo, Michigan 49008; $4,389 for 6 months beginning September 1, 1980.

This is a supplemental award to support completion of a project initiated under NSF Grant No. OPA 79-19672. The objective of the project continues to be to assess current knowledge relating to the role of earthworms in stabilization of organic substances and to determine additional research needed to apply this understanding to development of appropriate technologies for management of organic wastes of municipal, agricultural, and industrial origin. Topics at the workshop which was conducted in April 1980, included: morphology, taxonomy, and physiology of earthworms; their role in maintenance of soil fertility; and in cycling of organic matter with specific reference to municipal wastewater treatment plant sludges, mixed municipal refuse, pulp and paper mill wastes, agricultural crop, and livestock residuals. Proceedings of the workshop and a bibliography are being prepared for publication in Fall of 1980.

APPENDIX A

APPROPRIATE TECHNOLOGY RESEARCH PROGRAM FY 1980 AWARDS**

Institution/ Principal Investigator	Title of Project	Amount	Effective Date/ Award Duration	Page
Aerospace Research Corporation Joseph T. Hamrick	Cost Reduction in Irrigation Well Pump Application	$24,952.	9/1/80 6 months*	1
Antioch College/New England Graduate School Meade Cadot	Biological Stabilization of Organic Substances in Municipal Solid Waste by Composting	$36,974.	10/1/80 24 months	1
Cal Recovery Systems, Inc. George M. Savage	Testing and Evaluation of Equipment Used in Recycling Centers	$20,772.	9/1/80 6 months*	1
Calvin College James P. Bosscher	Evaluation of Curbside Municipal Solid Waste Sorting Systems	$15,855.	9/1/80 6 months*	1
Colorado State University Robert C. Ward	Management of Decentralized, On-Site Systems for Treatment of Domestic Wastes	$75,172.	9/1/80 24 months	1
Control Dynamics Company Sherman M. Seltzer	Correlation Between Early Linear Measurements and Future Performance and Carcass Characteristics in Cattle	$24,813.	9/1/80 6 months*	2
Donohue & Associates, Inc. Karl G. Voelkel	Small Scale Reclamation/Disposal of Toxic Porcelain Enameling Wastewater Sludges	$25,000.	9/1/80 6 months*	2
Dufresne-Henry, Inc. Gordon R. Pyper	An Inexpensive Biologic Method of Upgrading Lagoon Effluent	$25,000.	9/1/80 6 months*	2
Electro-Chlor Corporation John McCallum	Small Purification Systems	$25,000.	9/1/80 6 months*	2
Farallones Institute Michael J. Coblentz	Anaerobic Upflow Treatment of Household Wastewater	$6,850.	9/1/80 6 months	2
Florida, University of Howard T. Odum	Appropriate Environmental Systems for Waste Management	$27,299.	10/1/80 12 months	3
Flowerfield Enterprises Mary Appelhof	Biodegradable Solid Waste Conversion Into Earthworm Castings	$25,000.	9/1/80 6 months*	3
Floyd Browne Associates, Ltd. Robert C. Jones	Managing a Small Scale Solid Waste Resource Recovery Facility	$24,793.	9/1/80 6 months*	3
Forum, Ltd. Ronald G. Capalaces	Utilization of Wetlands for Wastewater Management[1]	$14,500.	4/1/80 1 month	3
George D. Ward & Associates George D. Ward	Elimination of Septic Tank Sludge Transport Via Truck	$24,728.	9/1/80 6 months*	3
George D. Ward & Associates George D. Ward	Susceptibility of Mt. St. Helens Volcanic Ash to Stabilization by Use of Organic Sludges	$11,687.	6/10/80 3 months	4
Glass & Ceramics International, Inc. Mir Akbar Ali	Development of Mineral Wool from Industrial Wastes	$24,961.	9/1/80 6 months*	4
Industrial Technology Research and Development Foundation, Inc. Norman A. Bergan	Appropriate Technology, Innovation, and Nonfarm Rural Development[2]	$145,088.	9/1/80 12 months	4
International Science and Technology Institute, Inc. Thomas B. Fricke	Permanent Cropping System for Small-Scale Farms	$25,000.	9/1/80 6 months*	4
JFCoates Inc. Joseph F. Coates	A Research Agenda on the Roles and Impacts of Appropriate Technology on Society, The Economy, and Technology Development	$7,400.	11/12/79 2 months	4
Kansas State University Mary Beth Kirkham	Appropriate Technology of Alternative Agricultural Practices on Drylands	$63,766.	8/15/80 24 months	4

**NOTE: Data for this report were taken from program records and therefore may differ from official National Science Foundation source documents which are generated from the Management Information System data base and which may contain different inclusions/exclusions.

*National Science Foundation, Directorate For Engineering and Applied Science, *Program Solicitation: Small Business Innovation Research*, Topic 12, Appropriate Technology, Phase I—Feasibility Research, Closing Date: January 21, 1980

[1] Supplement to Contract No. NSF PFR 79 23303, FY 1979, for $59,384

[2] Total Project $149,888, $4000 from Industrial Program

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Institution/ Principal Investigator	Title of Project	Amount	Effective Date/ Award Duration	Page
Maryland, University of James E. Alleman	Beneficial Use of Sludges in Production of Building Components	$41,140.	10/1/80 12 months	5
Michigan State University Denton E. Morrison	Appropriate Technology From a Social Science Perspective	$73,520.	9/1/80 12 months	5
Michigan, University of Robert H. Kadlec	Solids Movement in Wetlands	$37,528.	9/1/80 12 months	5
National Water Well Association Joseph D. Ritchey	Disequilibrium of Hydrogen Sulfide in Groundwater by Aeration	$22,686.	9/1/80 12 months	5
Navajo Community College G. Mark Schoepfle	The Applicability of Traditional Navajo Decision-Making to Modern Ecological Conditions	$56,288.	9/1/80 12 months	5
New Alchemy Institute Ronald D. Zweig	Feasibility of Small Scale Aquaculture Based on Recycling of Renewable Resources	$120,277.	10/1/80 15 months	6
New Mexico, University of Gerald W. May	International Workshop on Earthen Building Materials and Methods in Seismic Areas[3]	$30,000.	4/15/80 17 months	6
Notre Dame, University of Robert L. Irvine	Decentralized Systems for Management of Water, Solid and Liquid Wastes	$39,718.	4/1/80 8 months	6
Roy F. Weston, Inc. Arun K. Deb	Alternative Technologies for Small Water System Management	$99,987.	10/1/80 12 months	7
State University of New York Roy C. Hartenstein	Earthworm-Microbial Interactions During Stabilization of Organic Wastes for Recovery of Their Resource Values	$73,765.	6/1/80 12 months	7
Western Michigan University Robert W. Kaufman	Workshop on the Role of Earthworms in Stabilization of Organic Residues[4]	$4,389.	9/1/80 6 months	7

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[3] Total Project $64,935. $34,935 from Earthquake Engineering Program.

[4] Supplement to NSF Grant No. OPA 79-19672, FY 1979, for $43,890.

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APPENDIX B

NATIONAL SCIENCE FOUNDATION

bulletin

NATIONAL SCIENCE FOUNDATION WASHINGTON, D.C. 20550

NSF Announcements for December 1979

An experimental program in appropriate technology and a notice of NSF support of research equipment in small colleges are announced in this issue of the *NSF Bulletin*. NSF meetings, programs, positions open at NSF, and sources for more detailed information are also presented. Publications listed in the *Bulletin* may be obtained on the Publications Order Form on the back page. Telephone numbers are given in parentheses; all numbers are area code 202, unless otherwise indicated. The address of the National Science Foundation is 1800 G Street, N.W., Washington, D.C. 20550.

Appropriate Technology: in NSF's Engineering and Applied Science

NSF announces the establishment of an experimental program in Appropriate Technology, to be conducted in the Division of Intergovernmental Science and Public Technology, part of NSF's Engineering and Applied Science Directorate. For the purpose of this program, appropriate technologies are defined as those which are decentralized, require low capital investment, conserve natural resources, are managed by their users, and are in harmony with the environment.

The goals of the program are:

- To strengthen the science base needed to identify and develop promising appropriate technologies which have the potential for generalization beyond the initial application and which fall outside the responsibility or interest of mission agencies.
- To improve the understanding of appropriate technology as a concept in the development of science and technology and to better understand its role and impact on the U.S. society and economy.

Unsolicited proposals may be submitted at any time. For funding in fiscal year 1980, proposals should be submitted before Feb. 29, 1980. Copies of the Program Plan adopted by the National Science Board are available from Dr. Edward Bryan, Program Manager, Appropriate Technology, Rm 1108, NSF.

Recent NSF Program Reports

NSF Program Reports are a part of the continuing process of review and evaluation of NSF programs. They provide authoritative views of program objectives and accomplishments, and are accompanied by photographs, drawings, maps, charts, and diagrams. The following two reports are now available from the U.S. Government Printing Office, Wash., D.C. 20402: *Physiology, Cellular and Molecular Biology, July 1979* (Directorate for Biological, Behavioral, and Social Sciences). Request stock number 038-000-00419-1. Price is $2.25. *Information Science and Technology, August 1979* (Directorate for Scientific, Technological, and International Affairs). Request stock number 038-000-00418-2. Price is $2.00.

Appropriate Technology: in NSF's Science Education

NSF's Science Education Directorate will also be accepting proposals involving Appropriate Technology (see definition in left column). The following programs (listed with brochures explaining proposal procedures) are currently inviting proposals focused toward this growing technology:

- Development in Science Education (SE 80-50)
- Science for Citizens: Forums, Conferences and Workshops (SE 80-63)
- Public Service Residencies (SE 80-61)
- Ethics and Values in Science and Technology (SE 80-62)

Brochures may be requested on the Publications Order Form. For further information, contact Dr. Gregg Edwards (282-7900) for the program Development in Science Education, and Dr. Rachelle Hollander (282-7770) for the other three programs.

NSF-NIE Joint Program in Mathematics Education Using Information Technology

NSF and the National Institute of Education (NIE) have established a joint program to support the development of prototypes of software, courseware, and tests for the levels of mathematics that are usually taught in kindergarten through the 12th grade. The closing date for proposing *prototypes* in fiscal year 1980 is Jan. 31, 1980. The closing date for fiscal year 1981 is Aug. 19, 1980, subject to the availability of funds.

Proposals may be accepted at any time for supporting activities such as the identification of problems and opportunities and possibilities for further work on the topic.

For further information, request the guidelines (SE 80-59) on the Publications Order Form or call Ms. Dorothy Deringer, Development in Science Education (282-7910).

Advisory Committee Meeting, Division of Physics

The Advisory Committee for Physics will meet at NSF Jan. 31, and Feb. 1 and 2, 1980. Further information can be obtained by calling Dr. Laura Bautz, Division of Physics (632-4175).

The *NSF Bulletin* is issued monthly (except July and August) to disseminate information on NSF programs, policies, and activities. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget through Sept. 30, 1981. Editor: Barbara Tufty, Public Information Branch

APPENDIX C

APPROPRIATE TECHNOLOGY
A PROGRAM PLAN OF THE NATIONAL SCIENCE FOUNDATION★

Goals and Objectives

The goals of the NSF Appropriate Technology program are:

(1) to strengthen the science base needed to identify and develop promising appropriate technologies which have the potential for generalization beyond the initial application and which fall outside the responsibility or interest of mission agencies; and

(2) to improve the understanding of appropriate technology as a concept in the development of science and technology and to better understand its role and impact on U.S. society and economy.

The objectives of the program would be:

- to provide basic and applied research project support for individual proposals that can contribute to the science base of promising technologies or to the understanding of appropriate technology and its role in society;
- to encourage participation in the program by all groups concerned with appropriate technology who have sufficient high-quality research potential to compete for NSF support;
- to facilitate the incorporation of scientific research into appropriate technology development by coordination and joint funding with mission agencies and by encouraging linkages between the research community and other individuals or organizations interested in appropriate technology;
- to facilitate the dissemination of reliable information on appropriate technologies; and
- to monitor the evolution of the appropriate technology concept in the United States and, from time to time, recommend changes in the program operation or goals as appropriate.

To achieve these objectives, the program would:

- emphasize simplicity and brevity in both program announcements and proposals in order to make it easy for a wide range of individuals and organizations to submit proposals;
- ensure the participation of appropriate technology researchers and local user groups in the review process; this will not preclude obtaining reviews from all sources needed to assure both suitability and quality of the proposal for NSF support;
- establish an interagency coordinating committee on appropriate technology to avoid duplication of efforts, to identify areas of mutual interest and cooperation, and to encourage joint research efforts with mission agencies where appropriate;
- establish an advisory committee of scientists and engineers, appropriate technology practitioners, small business people, and representatives of other appropriate organizations to advise the program on content and progress, and to assist in the review of proposals; and
- encourage the involvement of local communities in research intended to be of benefit to them.

Program Operation Guidelines

In order to focus appropriate technology activities within the NSF and in relation to other agencies' activities, an Experimental Program Office will be established in the Intergovernmental Science and Public Technology Division of the Directorate for Engineering and Applied Science (EAS) of the National Science Foundation. EAS has been responsible for the bulk of the NSF approprite technology activity and will continue as the coordinator for all Foundation programs in appropriate technology.

This office will operate the program on an experimental basis. To meet its responsibility to monitor the evolution of appropriate technology and understand its role, function, and impact on society and the economy, the program, with the assistance of the advisory committee, will seek answers to questions such as:

- What is the science base required by appropriate technology?
- What are the implications of its development and use?
- What mechanisms are best suited to expand the range of performers to include individuals, small business, small community oriented educational institutions, and others with expertise and interest in appropriate technology?
- What institutional linkages are necessary to strengthen the technical and scientific base of appropriate technology?
- How can local communities be more effectively apprised of, and become involved in, the design and conduct of appropriate technology research intended to be of benefit to them?

★*Approved by the National Science Board, January, 17, 1980.*

Proposal Generation and Review Criteria

The typical method of operation at NSF involves the support of unsolicited proposals received in response to program announcements and guidelines to the research community. These proposals are reviewed using criteria for the selection of research projects as approved by the National Science Board. However, to meet the objectives of the AT program to involve diverse performer communities in a wide variety of geographic areas, a program announcement will be used.

This program announcement is planned in the AT research program addressed to:

1. the scientific and engineering research community
2. small business
3. local education agencies, e.g., community colleges, vocational/technical schools
4. local groups and individuals

Proposals received in response to this program announcement will also be evaluated using the NSF criteria. Special preference will be given to projects with clear potential utility (regional and/or national) and to projects which involve local communities in research intended to be of benefit to them.

Peer review on AT proposals will be more difficult than for more usual NSF activities; because, in many cases, success will depend on a mixture of enthusiasm and competence. Moreover, in some cases, promising technologies may turn out to be much more expensive to develop than was expected.

In all cases, NSF will continue to emphasize the high-quality review criteria contained in the Foundation's criteria for the selection of research proposals.

The Scientific Content of the Program

Aside from the studies of the possible impact of appropriate technology on society, which will require the skills of economists and other social scientists, it is expected that a wide range of scientific disciplines and engineering will be involved in research relevant to appropriate technology. However, since research represents only one component in the development and implementation of appropriate technologies, it is difficult to predict, in advance, the specific research areas that will be most needed.

The following are some examples of the scientific problems that have arisen in the past.

- Small-scale aquaculture using solar energy, algae and recycled waste was assumed to be a simple application of known practices. However, in combining the fish, algae, and waste in a confined space, many new problems in toxicity of water, proper balance between food and waste, and optimal growth strategies have arisen which require research by water chemists, biologists, and ecologists.
- While passive solar energy collection has been used since the early 1900's, attempts to develop solar collectors that economically transform energy to electricity have led to many still unanswered questions about collection, conversion, transmission, and distribution.
- Recycling of urban organic wastes was assumed to be an easily accomplished task. However, it was discovered that before it could be safe and effective, major problems of separating out heavy metal and inactivating viruses had to be resolved.
- Symbiotic planting is an alternate approach to fertilizer and pest control. People using this approach have looked to research on agricultural practices to determine how to enhance one plant's ability to fertilize another or kill the pests of another.
- Many appropriate technology innovators assumed building a wood stove to be a simple process but have discovered a need for scientific input to achieve a stove which is thermodynamically efficient and minimally polluting.
- Small-scale steel plants for the U.S. have the advantage of serving local markets, saving transportation costs, and utilizing scrap material. Scaling down the steel production process was not a simple application of known technology, however. It was necessary to achieve significant improvements in electric arc furnaces to make them economically viable.

Program Elements

Major topic areas identified during the workshop and forums for the appropriate technology program include:

- Appropriate Technology and Urban Innovation
- Small-Scale Industrial Technology
- Recycling, Resource Recovery and Conservation
- Appropriate Technology, and Rural Revitalization and the Small Farm
- Food and Nutrition
- Appropriate Technology—Its Roles and Impact on Society, the Economy and Technological Development

These elements are described in the following sections and examples of possible research topics are listed. Many fall within the direct responsibility or mission of other agencies. In these cases, the NSF role should be limited to projects emphasizing longer range or crosscutting issues, and with close coordination between NSF and the mission agency/agencies involved.

Appropriate Technology and Urban Innovation

Many experiments are taking place in cities around the country with appropriate technology based solutions to urban problems such as poor housing for low-income persons, waste, pollution and vulnerability of the area to external forces.

These experiments include cooperative schemes for neighborhood development using solar and wind energy, waste recycling and urban agriculture.

1. Support of scientific research needed to identify and provide the base for viable appropriate tech-

nology approaches to economic revitalization of low-income, urban areas.

2. Analyses of the potential of urban agricultural systems to provide significant healthful food for urban markets. Are they cost-effective? Are urban soils, water, and air so contaminated by pollution and toxic metals from the waste stream as to preclude healthful food production?
3. Analyses of the potential impact appropriate technology might have on providing jobs for the urban unemployed.
4. Evaluations of the relative advantages, reliability and generalizability of existing appropriate technology alternatives.

Small-Scale Industrial Technology

Many industrial processes currently make use of equipment or processes which are not adaptable to small-scale operations. It is argued that appropriate technologies which allow a greater degree of substitution of labor for capital and energy-intensive equipment, and/or can be economically operated on a smaller scale, may have the potential to increase job opportunities. New, smaller scale operations may also be more effective in the utilization of energy and transportation by being located nearer to an available labor supply, resources, and/or markets. Research is required to analyze these claims, identify promising technologies and processes, and develop the scientific base for those technologies found to be most cost-effective and compatible with the local labor supply, resources, and environment.

1. Identification, evaluation and development of the scientific base for technologies and processes which offer opportunities for the establishment of small-scale industry.
2. Comparative analyses of the potential capital, human and natural resource efficiences of scaled-down industrial processes contrasted with conventional ones.
3. Analyses of foreign experiences in small-scale production processes for their potential application in the U.S.

Recycling, Resource Recovery and Conservation

Present technology for resource recovery is adopted, in large part, from traditional methods for processing minerals, scrap materials and other waste. Most recovery plants now in operation or under construction are in major urban areas and require large tonnage (1,000 or more tons per day which requires a minimum population of around 600,000) to be economically feasible. Almost half of the U.S. population lives in areas too small to support recovery plants using this technology. The development of less expensive systems that could be economically used by small-to-medium-sized communities requires research to understand the most appropriate technologies.

Research can help to determine the economic and resource conservation needs, and technical feasibility of smaller systems which might be produced and located in such a way as to reduce both capital and transportation costs, in order to put resource recovery and waste reduction within the fiscal reach of many more communities.

1. What are the sectors of greatest resource waste in the economy and what conservation and recovery techniques can be economically applied to these sectors?
2. What are the technical and economic barriers to locally based resource recovery and conservation?
3. What are the technical developments needed to enable efficient small-scale waste recovery?
4. What are the scientific problems which prevent economic recycling of potentially valuable materials?

Appropriate Technology, Rural Revitalization and the Small Farm

Concern has been expressed that (due to extreme vulnerability to external economic forces) viable rural communities may cease to exist in the United States in another generation. Changing social and economic conditions may make some types of rural communities nonviable; however, a broader choice of technology and development alternatives may help preserve the most desirable features of our rural environment. Most appropriate technology attention in rural areas has focused on the problems of retaining or conserving small family farms and small rural businesses in ways which will encourage greater use of local materials and labor.

1. What would be the effects of a more self-sufficient approach on the economic viability and quality of life of rural communities?
2. Can research provide the ways to develop economically competitive new crops or new products that can stimulate the growth of rural communities?
3. What are the potential effects on both the local and national economy of the widespread adoption of small scale and more biologically dependent agricultural technology?
4. Japan, Egypt, Taiwan and Israel are examples of countries whose small farmers contribute significantly to food production. Given the differences in terrain and socio-economic systems, what can be learned from these countries about alternative technologies that would be suitable for the United States' small farmer?

Food and Nutrition

The appropriate technology debate points to possible detrimental impacts of capital and chemical intensive agricultural practices on the soil, environment, nutrition, and human health. Among these are concerns about the impacts of the widespread and frequent use of pesticides and herbicides on the quality of food and the environment.

1. Do alternative agricultural practices emphasizing organic fertilizers, biological pest control, and soil conserving tillage significantly affect costs or productivity and the quality of food? How do they compare to the use of chemical pesticides, herbicides and other conventional agricultural practices? Does the use of alternative practices point to new research needed to improve their effectiveness?

APPROPRIATE TECHNOLOGY—ITS ROLES AND IMPACT ON SOCIETY,THE ECONOMY AND TECHNOLOGICAL DEVELOPMENT

There is need to understand the role that the concept of appropriate technology might play in future technological and economic growth in the United States; whether it is responsive to society's needs for future growth, and whether there are currently undue regulatory, economic, or institutional barriers to the appropriate technology concept.

Social and Economic Implications of Appropriate Technology

More widespread use of appropriate technology with its emphasis on local economic development and local self-sufficiency may have important implications for the economic and social structure of the United States, which should be explored to provide meaningful analyses of the long-run advantages and disadvantages of this approach.

1. What socio-economic implications are implied by the concept of appropriate technology? What would be the effect on rural poverty, innovation and job creation, distribution of population, aggregate markets and aggregate rates of growth?
2. How would the use of appropriate technology affect industrial efficiency and worker satisfaction?
3. What are the implications for the decisionmaking process and type of projects selected for research and development activities?
4. What criteria can be developed to determine the "appropriateness" of a technology and at what stage would it be most useful to introduce these considerations into the decision process?

Role of Appropriate Technology in Technological Innovation

Many appropriate technology practitioners contend that there are undue regulatory, economic, and institutional barriers to widespread implementation of appropriate technology. Others argue with equal conviction that any barriers encountered by appropriate technology represent the normal constraints applied to any new technological development.

Research in this area would investigate barriers to the adoption of new technology and whether there is any systematic bias against appropriate technology concepts.

1. What are the major regulatory, financial, and institutional barriers faced in attempting to introduce appropriate technology into the market? Are they necessary to protect the health and welfare of the public? Are they particularly onerous for the smaller scale, decentralized technologies?
2. What are the major technical and managerial barriers to the development of appropriate technology small businesses and cooperatives?
3. How can local groups and innovators interested in appropriate technology best utilize the skills and expertise of R&D institutions—universities, community colleges, etc., to broaden the range of available technologies and improve the effectiveness and reliability of technologies chosen? Are special mechanisms, such as regional appropriate technology innovation centers needed to link the skills of the scientific and small business communities with appropriate technologists?

Manpower and Training Issues in Appropriate Technology

Many people assert that appropriate technology is a new means for job creation and economic development because it is usually more labor intensive than conventional technology.

1. Does appropriate technology provide more job opportunities, and are the jobs created by appropriate technology better matched to U.S. labor and economic needs than those of more "conventional" technologies?
2. What are the opportunities and implications for new careers from the development of appropriate technology?
3. Are there special training needs for people interested in appropriate technology; and if so, how should this training be provided?

APPENDIX D

NATIONAL SCIENCE FOUNDATION
Office of the Director
WASHINGTON, D.C. 20550

Notice No. 80 February 15, 1980

IMPORTANT NOTICE TO PRESIDENTS OF UNIVERSITIES AND COLLEGES AND HEADS OF OTHER NATIONAL SCIENCE FOUNDATION GRANTEE ORGANIZATIONS AND POTENTIAL GRANTEES

Subject: **Appropriate Technology**

The National Science Foundation plans to support projects in research and education which will strengthen the base of scientific knowledge, trained personnel, and public understanding needed to identify and develop promising appropriate technologies. Only projects both with the potential for generalization and use well beyond the initial application and which are outside the responsibility or interest of mission agencies will be considered for support.

Technologies are more likely deemed appropriate when they are developed in consultation with people affected by them, and when they are chosen from a wide range of alternatives after consideration of the consequences for the social and natural environment. Appropriate technologies are characterized by their possession of many of the following qualities: They are decentralized, and are amenable to management by their users; they are small or intermediate in scale, and are more labor than capital intensive; they encourage local adaptation to diverse community needs and take into account locally available natural and human resources; they result in solutions that conserve natural resources and that are in harmony with the environment.

The *Directorate for Engineering and Applied Science* is implementing its support of scientific and engineering research on appropriate technology in the Division of Intergovernmental Science and Public Technology. The goals of the program are:

- To strengthen the science base needed to identify and develop promising appropriate technologies which have the potential for generalization beyond the initial application and which fall outside the responsibility or interest of mission agencies.
- To improve the understanding of appropriate technology as a concept in the development of science and technology and to better understand its role and impact on U.S. society and economy.

The topics that are included within the scope of the program plan approved by the National Science Board are: appropriate technology and urban innovation; small-scale industrial technology; recycling, resource recovery and conservation; appropriate technology, rural revitalization and the small farm; food and nutrition; and appropriate technology—its roles and impacts on society, the economy and technological development. Proposals directed principally toward technologies for alternative energy sources and energy conversion systems and related topics are not eligible for support from this program.

Unsolicited proposals may be submitted in accord with "Grants for Scientific Research" (NSF 78-41), "Addendum to NSF 78-41 For Unsolicited Proposals to Certain EAS Divisions" (EAS 79-71), and "Program Announcement—Experimental Research Program on Appropriate Technology."

Programs in the *Directorate for Science Education* (SE) are broadly concerned with education in the scientific principles and good engineering practice which underlie appropriate applications of technology. Proposals for projects which use examples of appropriate technology to illustrate and introduce *generally* applicable principles and practices of science and engineering should be prepared in accord with the guidelines of each specific program. Brief descriptions of SE programs and order numbers of their guidebooks are contained in "Guide to Science Education Programs, FY 1980" (SE 80-1).

In addition, there are several programs within SE which are more directly concerned with increasing understanding of scientific principles for appropriate technologies and of their social and environmental consequences. These programs (and their respective guidebooks) are:

- Science for Citizens:
  Forums, Conferences and Workshops (SE 80-63)
  Public Service Science Residencies (SE 80-61)
- Ethics and Values in Science & Technology (SE 80-62)
- Development in Science Education: (SE 80-50)
  Science, Technology and Society
  New Knowledge for Productivity

Copies of all of these publications may be obtained at no cost by writing to:

Forms and Publications Unit
National Science Foundation
1800 G Street, NW
Washington, DC 20550

Grants are administered in accord with the terms and conditions of NSF F.L. 118, Grant General Conditions, copies of which may be requested from the NSF Forms and Publications Unit cited above. More comprehensive information is contained in the *NSF Grant Policy Manual, Revised October 1979*, available through a subscription, \$9.00 domestic and \$11.25 foreign, offered by the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402. Periodic looseleaf update supplements through numbered transmittal notices are available only under the GPO subscription.

Richard C. Atkinson

Richard C. Atkinson
Director

REQUESTS FOR ADDITIONAL INFORMATION

Additional information, including NSF 78-41, NSF F.L. 118 and the *Appropriate Technology Program Plan* referred to in this announcement, is available from the Appropriate Technology Program, Division of Intergovernmental Science and Public Technology, National Science Foundation, Washington, D.C. 20550. The telephone number is (202) 634-4333.

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APPENDIX E

PROGRAM ANNOUNCEMENT*

National Science Foundation
Directorate for Engineering and Applied Science
Division of Intergovernmental Science and Public Technology

Experimental Research Program on Appropriate Technology

INTRODUCTION

The Division of Intergovernmental Science and Public Technology of the National Science Foundation plans to award approximately $1.8 million in Fiscal Year 1980 to support an experimental research program in Appropriate Technology. For the purpose of this program, appropriate technologies are defined as those which possess many of the following qualities: they are decentralized, require low capital investment, are amenable to management by their users, result in solutions that conserve natural resources, and are in harmony with the environment; they are small or intermediate in scale, take into account site-available natural and human resources, and are more labor than capital-intensive.

The goals of the program are to:

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*Approved by the National Science Board, January 17, 1980.

- Strengthen the science and engineering base needed to identify and develop promising appropriate technologies which have the potential for generalization beyond the initial application and which fall outside the responsibility or interest of mission agencies.
- Improve the understanding of appropriate technology as a concept in the development of science and technology and to understand better its role and impact on the United States' society and economy.

PROGRAM DESCRIPTION

The program plans to support research on the following appropriate technology topics:

- Appropriate Technology and Urban Innovation.
- Small-Scale Industrial Technology.
- Recycling, Resource Recovery and Conservation.
- Appropriate Technology, Rural Revitalization and the Small Farm.
- Food and Nutrition.
- Appropriate Technology—Its Roles and Impacts on Society, the Economy and Technological Development.

Additional information on these topics is contained in the *Appropriate Technology Program Plan* available through the Division of Integovernmental Science and Public Technology.

ELIGIBILITY FOR SUPPORT

This program will consider proposals for the support of research responding to the definition and goals of the program and addressing topics described in this announcement. To be eligible for support under this program, the methodology proposed must be based on sound scientific or engineering principles and be suitable for achieving the project's objectives.

The program will not provide support for product design, product or technology development, technical assistance, demonstrations, or economic development projects. Clinical, market, classified, and weapons-related research are not funded by NSF. Technologies for alternative energy sources, energy conversion, and related topics are excluded because they fall within the scope of an appropriate technology program of the U.S. Department of Energy.

WHO MAY SUBMIT

Proposals may be submitted by U.S. colleges, universities, community colleges, nonprofit and for profit organizations, or by units of state or local government. Proposals from individuals may be submitted but are supported only in special circumstances (see *Grants for Scientific Research,* NSF 78-41 for details). Cost sharing is required and no fees may be paid.

SUBMISSION DATE

Research proposals should be submitted to the Foundation as early as possible. Proposals received too late for consideration in the fiscal year ending September 30, 1980 will be retained for consideration for support in the fiscal year beginning October 1, 1980, subject to continued availability of funds.

SELECTION PROCESS

All proposals will receive a peer review based on criteria established by the National Science Board and specified in *Grants for Scientific Research* (NSF 78-41), pp. 9-10. Reviewers qualified to judge research will be asked to judge each proposal on its scientific and technical merit and on its potential benefits. Other factors that will be considered are possible duplication of research being funded by other agencies and evidence of the ability of the investigator(s) to conduct the proposed research. Brevity will facilitate review. The project description normally should not exceed 15 single-spaced pages.

HOW TO SUBMIT

Twenty (20) copies should be submitted to: Central Processing Section, National Science Foundation, Washington, D.C. 20550, Attention: Appropriate Technology, ISPT.

One copy of the proposal must be signed by the principal investigator(s) and an official authorized to commit the institution in business and financial affairs. Other copies should show the names and titles of those who have signed the original.

The format of the cover page and summary proposal budget pages are contained in the NSF publication, *Grants for Scientific Research* (NSF 78-41).

TERMS OF AWARDS

All grant awards will be made, and administered in accordance with the *NSF Grant Policy Manual,* available by subsciption from the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402. Each award will include standard terms and conditions for grants contained in *General Grant Conditions* (NSF F.L. 118). For regulations concerning rights to patentable inventions under NSF grants, see Title 45, *Code of Federal Regulations,* part 650.

APPENDIX F*

PROGRAM SOLICITATION
for
SMALL BUSINESS INNOVATION RESEARCH
SUMMARY

The National Science Foundation (NSF) invites those companies within the Nation's small business community **which have strong research capabilities in applied science or engineering** to submit proposals to its Engineering and Applied Science (EAS) Directorate.

Under this program solicitation entitled **Small Business Innovation Research,** EAS plans to support high quality applied research proposals on important scientific or technical problems or opportunities **that could have significant public benefit if the research is successful.** Proposals will be considered in the following topic areas:

		Code
1.	Advanced Measurement Research	5315
2.	Advanced Production Research for Discrete Parts Manufacturing	5514
3.	Industrial Processes	5315
4.	Deep Mineral Resources	5317
5.	Alternative Biological Sources of Materials	5341
6.	Microbial Fertilizers, Activators, and Conditioners	5316
7.	Human Nutrition	5343
8.	Advanced Marine Farming	5317
9.	Groundwater Pollution	5317
10.	Earthquake Engineering, Architecture, and Urban Planning	5597
11.	Science and Technology to Aid the Handicapped	5342
12.	**Appropriate Technology**	5351
13.	Applied Research Project Support	5315

It is anticipated that this solicitation, like its predecessor in 1979, will result in approximately 50 awards of up to $25,000 each to individual small business organizations under phase I of a three-phase program. Phase II will provide for larger awards to those companies with approaches that appear most promising as a result of the first phase. Phase III is the development phase to pursue commercial applications, and will not be funded by NSF (see below).

This solicitation is for phase I proposals only at this time.

EAS is interested in **research on advanced concepts** in any of the following scientific or engineering areas, particularly where the research may serve as a base for technological innovation:

Sciences—physical, chemical, mathematical, biological, social, and behavioral,

Engineering—all fields of engineering, or any combination of these areas.

Note: NSF does not fund product development, technical assistance, or pilot-plant efforts, It normally will not support clinical research nor does it fund market, classified, or weapons-related research. NSF also does not fund research that is duplicative of research supported by other Federal mission agencies such as energy research supported by the Department of Energy.

Converting Research to Technological Innovation and Commercial Applications

A second important goal of the solicitation, in addition to the funding of applied science and engineering research, is the conversion of that research into technological innovation by private firms for its socioeconomic benefits to the Nation. Therefore, on an optional basis, the solicitation includes an incentive for proposers to obtain a **contingent commitment in phase II for private follow-on funding** to continue the innovation process where it is felt that the research also has commercial potential. Federal funding pays for research on EAS objectives (phases I and II); private capital provides for possible follow-on developmental funding to meet commercial objectives (phase III).

Proposers who feel that their research has the potential to meet market needs, **in addition to meeting the research objectives of the solicitation,** are encouraged to obtain private venture capital or other follow-on funding to pursue the development phase. The commitment for the follow-on funding must be from a third party and **at least equivalent to Federal research support** requested in phase II. The commitment should be obtained during or immediately following phase I and should accompany the phase II proposal. This commitment may be contingent on the EAS supported research meeting a few specific technical objectives in phase II which, if met, would justify private investment to pursue further development for commercial purposes in phase III.

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*Excerpt from NSF 79-59, closing date January 21, 1980.

Phase I proposals which briefly describe a plan for obtaining and using follow-on funding for further development, and Phase II **proposals that provide a commitment for follow-on funding, will receive extra consideration as a point of merit in the evaluation process.** The maximum value will be given when the phase II proposal is accompanied by a signed contingent agreement for follow-on funding equal to or in excess of the request for Federal support in phase II.

In cases where a commitment for follow-on funding is obtained under Phase II, the contractor will be permitted to obtain commercial rights to an invention made in phase II, subject to certain conditions, in accordance with NSF patent regulations. **Rights will be granted at the time of actual investment** of funds equivalent to phase II Government support and the submission of an adequate **business plan** to bring the invention to the marketplace.

The objectives of the solicitation are to stimulate technological innovation in the private sector, increase the application of EAS supported research results, and improve the return on investment from Federally funded research.

Phase I—Feasibility Research

Phase I is to conduct a feasibility related experimental or theoretical research effort on the proposed innovative idea or approach. NSF will provide funds for feasibility research of up to $25,000 over a period not to exceed six (6) months. The study should concentrate on that **research** which will significantly contribute to proving the feasibility of the approach or concept and which would be prerequisite to futher research and EAS support in phase II.

Phase I also is designed to reduce the investment of time and cost to small firms in preparing a formal proposal under this solicitation as compared to other NSF formal proposals. The research plan should not exceed 10 pages, and the entire phase I proposal is limited to 20 pages, including the cover page, budget, and any attachments. The proposal should be directed at:

1. Identification and significance of the **specific** research problem or opportunity addressed (includes both phase I and phase II);
2. The specific phase I research objectives; and
3. The phase I research plan (in detail) to achieve the objectives.

Awards will be made by NSF based upon evaluation of phase I proposals. All proposers will be informed of those receiving awards, and successful proposers will then have six (6) months to carry out their proposed phase I effort. Phase I results are to be submitted in a final report.

It is anticipated that Phase I will result in fixed-price awards of a specific amount up to $25,000. Since price competition is not a factor in phase I, the basis of selection will be the best value to the Government in terms of the criteria described on page 18. Payments will be made as follows: one-third at the time of award, one-third three months after award, and the remainder upon acceptance of the final report by NSF.

Phase II—Principal Research Project

Only awardees under phase I will be eligible to submit a formal proposal following completion of the first phase to carry out the principal research effort in phase II. Phase II will require more comprehensive, standard NSF/EAS proposals which must be submitted within sixty (60) days following the expiration of the phase I award to be considered part of the solicitation. Phase II proposals may be submitted earlier, but not prior to submission of the phase I final report.

The funding and the period of performance under phase II will provide for from 12 to 24 months of support for up to a two-to-three professional person-year level of effort annually, depending upon the scope of the research. Phase II awards will be contingent upon evaluation of the phase I report and the phase II proposal.

Phase III—Development

This phase, conducted by the small business firm, is privately funded from a third party source through the exercising of the follow-on funding commitment. Phase III is to pursue commercial objectives from the EAS research base established in phases I and II.

A proposal must be limited to one topic or sub-topic. The same proposal may not be submitted under more than one topic. However, an organization may submit separate proposals on different topics or different proposals on the same topic under this solicitation.

Rights may be obtained by proposers for patentable inventions resulting from the phase I or phase II research under the conditions described more completely on page 21 of this solicitation.

This solicitation does not obligate the National Science Foundation to make any specific number of awards under either phase I or phase II.

Eligibility

Each organization submitting a proposal must qualify as a small business for research purposes as defined by the Small Business Administration (SBA). In addition, the primary employment of the principal investigator must be with the small business firm at the time of award.

Schedule

To be considered for this program solicitation, phase I **proposals must be received by the National Science Foundation by 5:00 p.m., EST, January 21, 1980.** Awards are anticipated by July 31, 1980, for a phase I performance period of August 1, 1980—January 31, 1981. Phase II awards are anticipated by August 31, 1981.

DEFINITIONS

The following definitions apply for the purposes of this solicitation:

- **Applied Research**—Investigations directed at the discovery of new scientific knowledge which may have commercial objectives with respect to potential products or processes.
- **Development**—Technical activities of a nonroutine nature concerned with translating research findings or other scientific knowledge into products or processes. For example, where the original research proposed is minimal and the problem is essentially one of design or packaging of existing knowledge or technology into a new format or is the testing of a product for commercial purposes, the effort is development.
- **Clinical Research**—The diagnosis or treatment of disease, abnormality, or malfunction in people or animals or testing of drugs or procedures for their treatment.
- **Small Business**—A concern organized for profit, independently owned or operated, not dominant in the field in which it is bidding, and having an average of not more than 500 employees (full-time, part-time, temporary, or other) during the previous 12-month period in all affiliated firms. (From Code of Federal Regulations, Title 13, Part 121 as amended).
- **Minority Owned and Operated Firm**—A qualified small business firm that is owned, controlled and operated by one or more minority persons (Black, Hispanic, Native American or Asian) who are citizens of the U.S.
- **Woman Owned and Operated Firm**—A qualified small business firm that is owned, controlled, and operated by one or more women who are citizens of the U.S.

SMALL BUSINESS INNOVATION RESEARCH PROGRAM SOLICITATION BACKGROUND

NSF and EAS

The National Science Foundation is an agency of the Federal Government. The Foundation conducts no inhouse research, other than analytic and policy studies, and seeks to support high quality research proposed to it by academic and other not-for-profit organizations, industry and State and local governments.

The Directorate for Engineering and Applied Science is one of seven NSF directorates. Its principal research interests are applied science and engineering in the physical, chemical, mathematical, biological, social and behavioral sciences, all fields of engineering, and in problem-focused research applications areas which include: alternative biological sources of materials, earthquake hazards mitigation; human nutrition; and science and technology to aid the handicapped.

Innovation and Small Business

Innovation is a subject of major importance to the Nation. Technological innovation is often credited with being the most important single contributor to the economic strength and the standard of living of the United States.

Innovative research in the fields of science and engineering has made significant contributions to those achievements and to the resolution of many problems of the past. At the same time, the Nation continues to face many problems as well as new opportunities of increasing complexity and technical content.

Recognizing that small business has an established record for innovation, EAS is interested in encouraging the participation of this important national resource in this NSF program.

All types of small business organizations may submit proposals to EAS, including high technology, R&D, manufacturing, and service firms. Companies with outstanding scientific or engineering competence in highly specialized product, process or service areas may want to consider the research, through a proof-of-concept experiment, necessary to apply their expertise to the topic areas in the solicitation. Such research could make significant contributions to the Nation through the solution of important problems and stimulating new opportunities. In turn, the EAS supported research may provide the small business concern with the basis for new potential products, processes, and services.

GENERAL CONSIDERATIONS

Research Proposals to NSF

The purpose of research proposals to NSF is to provide a statement that contains sufficient information to persuade NSF, and members of the research community who review the proposal and advise NSF, that the proposed work represents a sound approach to the investigation of an important scientific or engineering question and is worthy of support under the stated NSF criteria.

A proposal should be self-contained and written with the care and thoroughness accorded papers for publication. Each proposal should be reviewed carefully by the applicant and possibly by others knowledgeable on the subject to ensure inclusion of data essential for evaluation.

Scientific or Technical Merit

The scientific or technical merit of the proposed research is the primary concern for all research supported by the National Science Foundation. Proposed research must address a single topic of the solicitation or an important segment of a topic. The quality of the research proposed will be the principal basis on which proposals will be evaluated and funded.

Commercialization as a Second Objective

The proposed research must be responsive to the EAS program objectives. However, the same research often can serve as the base for technological innovation, new commercial products, processes, or services. This also represents a desirable socio-economical objective, and such proposals are encouraged.

Proposals must be confined principally to **applied science or engineering research** which may be carried through a **technical proof-of-concept experiment** where necessary. **Proposals principally for the development of proven concepts toward commercialization or for market research should not be submitted,** since such efforts are outside the authority of NSF to support and are considered the responsibility of the private sector. Commercialization is the objective of the follow-on funding option, which is to fund development efforts in phase III, as a continuation of the research supported by NSF under phases I and II.

High Risk/High Payoff Research

Another objective of the solicitation is to increase the incentive and opportunity for small firms to undertake high risk research that has a high potential payoff if the research is successful. Major technological innovations often require such high risk investment which can effectively lower the risk for follow-on investors. Federal support of the front-end research on new ideas, often the highest risk part of the innovation process, may provide a mechanism for such research that otherwise can find little funding, particularly in the case of small business.

Phase I—Feasibility Research

Phase I is to conduct a feasibility related experiment or theoretical research effort on the proposed innovative idea or approach. The feasibility study will be for up to $25,000 over a period not to exceed six (6) months. The study should concentrate on that **research** which will significantly contribute to proving the feasibility of the approach or concept and which would be a prerequisite to further research and EAS support in phase II.

Phase II—Principal Research Project

Only awardees under phase I will be eligible to submit a formal proposal following completion of the first phase to carry out the principal research effort in phase II. Phase II will require more comprehensive, standard* NSF/EAS proposals which must be submitted within sixty (60) days following the expiration of the phase I contract period to be considered part of the solicitation. Phase II proposals may be submitted earlier but not prior to submission of the phase I final report.

The funding and the period of performance under phase II will provide for from 12 to 24 months of support for up to a two-to-three professional person-year level of effort annually, depending upon the scope of the research. Phase II awards will be contingent upon evaluation of the phase I report and the phase II proposal.

Phase III—Development

This phase, conducted by the small business firm, is privately funded from a third party source through the exercising of the follow-on funding commitment. Phase III is to pursue commercial objectives from EAS research base established in phases I and II.

Project Responsibility

The responsibility for the performance of the principal investigator, and other employees or consultants who carry out the proposed work, lies with the management of the organization receiving an award.

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*Although phase II proposals are solicited, NSF s Grants for Scientific Research or EAS' "Guidelines for Preparation of Unsolicited Proposals" will be provided to phase I awardees for format guidance in preparing phase II proposals.

RESEARCH TOPICS

This is a solicitation for research proposals on advanced concepts from small business firms which have strong research capabilities in applied science or engineering.

A proposal must be limited to one topic or sub-topic. The same proposal may not be submitted under more than one topic. However, an organization may submit separate proposals on different topics or different proposals on the same topic under this solicitation.

Proposals may respond to any of the topics below or to specific, sub-topic areas within them. Research may be carried through a proof-of-concept experiment, where necessary.

Note: NSF does not fund product development, technical assistance, or pilot-plant efforts. It normally will not support clinical research nor does it fund market, classified, or weapons-related research. NSF also does not fund research that is duplicative of research supported by other Federal mission agencies such as energy research supported by the Department of Energy.

Appropriate Technology

Research leading to appropriate technology will be funded under this solicitation in the following three specific areas **only:**

- **Small-scale Industrial Technology**—Equipment and processes research.
- **Recycling, Resource Recovery, and Conservation**—Research leading to small-scale technology for these areas.
- **Technology to Improve the Self-Sufficiency of Small-Scale Farms**—Equipment, process, and food processing research.

Appropriate technology has been defined as technology which is decentralized, requires low capital investment, is amenable to management by its users, in harmony with the environment and conserves natural resources. It is generally understood to be small or intermediate in scale and innovative in design. Most appropriate technology in the U.S. is now concentrated in the areas of energy, conservation, waste, and agriculture. The concept of appropriate technology needs to be expanded so that it can significantly increase the productivity and efficiency of small-scale operations.

Examples of research projects supported by NSF that incorporate these principles have included:

- Resource conserving agricultural production methods;
- The utilization of wetlands for management of wastewater;
- Management of agricultural, industrial, and municipal organic wastes to improve soil and recycle nutrients;
- Assessment of semi-closed, renewable resource-based aquaculture systems; and
- Utilization of waste heat in aquaculture.

Under this topic, NSF is interested in funding **research** that can contribute to the science base for promising **small-scale** technologies which have the potential for generalization in specific areas beyond their initial application. The research must be of high quality and may be carried through a proof-of-concept experiment. However, NSF will **not** support development efforts on already concept-proven ideas, products, or processes. Proposers must justify that the approach has clear advantages over other existing small-scale technologies in the same field.

Research will be supported in the following areas:

a. **Small-scale Industrial Technology**—Many generally available industrial processes and many types of industrial equipment are capital and energy intensive and may not be efficient for small-scale operations. New job opportunities and greater productivity and efficiency resulting in lower overall costs might be possible if better small-scale processes and equipment were available. This is particularly true of many processes and equipment that were developed when lower cost energy, labor, and capital were available and when environmental factors were of little concern.

NSF is interested in funding the **research** that will lead to new industrial processes and equipment that are small in scale, significantly lower in both capital cost and total operating cost, and meet environmental constraints, as well as competition in the marketplace.

b. **Recycling, Resource Recovery, and Conservation of Materials**—Many present technologies for resource recovery from societal residues depend upon large-scale operation for their technical and economic viability. They also evolved under conditions when the cost of energy, materials, transportation, and capital were lower than today. Conditions now suggest the possibility that smaller systems might be designed to achieve both resource recovery and conservation objectives more efficiently and effectively than large-scale systems.

Research is needed on new small-scale approaches to the recycling of materials, resource recovery, conservation processes and equipment. Research in these areas should concentrate on new concepts for the economic recovery of usable resources or a significant reduction in their use.

c. **Technology to Improve the Self-Sufficiency of**

Small-Scale Farms—EAS will support **research** leading to the development of equipment and processes that will significantly increase the self-sufficiency of small-scale farms. Such research should take into consideration the need for substantially lower capital costs, energy use, and environmental constraints and may involve innovations in food processing appropriate to small scale.

Proposals principally for the **development** of already research-proven ideas or for incremental improvements in existing processes or equipment will not be funded. EAS is interested in major advances that may be possible in this field due to recent breakthroughs in science or technology which may make new approaches to the equipment and process needs of the small-scale, independent farmer and food processor possible.

Proposals directed principally toward technologies for alternative energy sources and energy conversion systems and related topics are not eligible under this solicitation and should be explored with the Department of Energy which also conducts a program in appropriate technology. For information on this program, contact the U.S. Department of Energy, Appropriate Technology Program, 400 First Street, N.W., Washington, DC 20585.

END

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